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March 29, 1995

EX PARTE

William F. Caton
Acting Secretary
Federal Communications Commission
Mail Stop 1170
1919 M Street, N.W., Room 222
Washington, D.C. 20554

Dear Mr. Caton:

DOCKET FILE COPY ORIGINAL

Re: CC Docket No. 94-54 - Equal Access and Interconnection Obligations Pertaining to
Commercial Mobile Radio Service

A copy of the attached article, relating in part to potential PCS technology standards, was submitted to Rudolfo M. Baca, Legal Advisor to Commissioner James H. Quello. Please associate this material with the above-referenced proceeding.

We are submitting two copies of this notice in accordance with Section 1.1206(a)(1) of the Commission's Rules.

Please stamp and return the provided copy to confirm your receipt. Please contact me should you have any questions or require additional information concerning this matter.

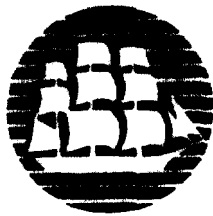
Sincerely,



Attachment

cc: Rudolfo M. Baca

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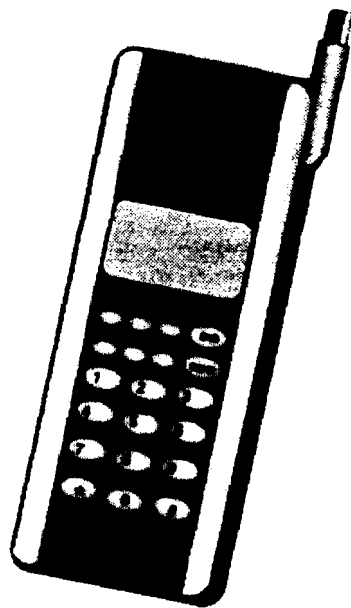
CS FIRST BOSTON

Industry: Wireless Telecommunications
February 21, 1995
TS0419

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PCS: A Critical Piece of the Communications Puzzle

Personal Communications Services Help Fill in the Blanks



- PCS auctions introduce new competition into the communications industry.
- Wireless demand will be very high as competition and technology drive lower prices and broader applications, enabling mass-market affordability and interest.
- Longer term, wireless services will be one part of an integrated communications offering, including wired, voice, video, and data services.
- Our valuation framework indicates that long time horizons are implied in the prices being paid at auction for the PCS spectrum.

PCS: A Critical Piece of the Communications Puzzle

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PCS: A Critical Piece of the Communications Puzzle

Sometime in the Not-Too-Distant Future...

Bill rose early. He was concerned about the big meeting today. He picked up his telephone and called Mary's number to confer on the slides for the meeting. He was surprised to find she was at the office. They realized that Jim had the key file to complete the slides, so they dialed his number. Jim was sipping his coffee on the commuter train when his personal digital assistant vibrated in his pocket. He slipped it out and answered the call. "Jim, this is Bill and Mary. We need the Penske file for our presentation in one hour." Jim tapped some icons on his PDA, and the file was transmitted to Mary's computer. While still conversing, Bill headed out the door of his house to his car. The final changes to the presentation were agreed upon as Bill drove down the highway, Jim walked through the train station, and Mary rode the elevator.

What is fascinating about this vignette is that the individuals are reached no matter where they happen to be. Bill does not know where Mary or Jim are when he dials their numbers. The telephone number represents a person, not a place. The wireless network finds the person, no matter where he or she is. As the people move from home to car, from train to station, and from office to elevator, the conversation continues uninterrupted. What previously was downtime has been turned into valuable work time. Productivity is enhanced. What may surprise the reader is that we are close to this vision becoming a reality. How? The answer is PCS.

What Is PCS?

PCS is an acronym for personal communications services. It is a very broad term encompassing many communication modes. Cellular telephones are personal communications devices. So are pagers. Handheld computers known as personal digital assistants, or PDAs, fall under the PCS rubric. The "one number, one person" vision we described above is also PCS.

When one reads about PCS today, it is typically in a very specific sense. *It describes the radio spectrum, not the services that may be offered over that spectrum.* Namely, it refers to 140 megahertz (MHz) of radio frequencies in the 1900 MHz band

of the electromagnetic spectrum. Licenses for the exclusive rights to 120 MHz of this spectrum are being auctioned by the Federal Communication Commission. (Table 1 shows various radio spectrum allocations and the uses to which they are put.) The first auctions for narrowband spectrum took place in 1994, raising \$1.01 billion from paging companies. The second series of auctions—for two 30 MHz broadband licenses, which is still under way, has already raised \$5.5 billion, and two more auctions—for four more licenses—have not yet taken place. *The \$64 billion question is: What makes this spectrum so valuable to the bidders?*

To answer this question, one must consider what this new spectrum will be used for. Different bidders in the auction certainly have different plans, and hence different perceived values. However, in general, the current giants of the wireless business (which are also the "wired" giants) expect to initially and primarily utilize the new spectrum as a way to expand their wireless footprint. Secondly, they view it as a competing access route to the end user.

The Importance of PCS to Investors

Despite the various segments in wireless, this report is focused on voice-oriented broadband PCS. Wireless is still an unknown quantity, but it appears destined to assume center stage in the development of telecommunications. Wireless has become a driving force in mergers and acquisitions in telecom. The \$18 billion AT&T acquisition of McCaw Cellular, and its near-certain \$3.5-4 billion acquisition of LIN Broadcasting represent the high-water mark of cellular consolidation. These deals were driven by AT&T's need to round out its full-service offerings, position itself on the wireless growth curve, and provide alternative channels of access to end users.

Many deals and affiliations have been made over the last 12 months as companies, anticipating rising competition in the wireless industry, try to expand their footprint without buying PCS spectrum. Bell Atlantic and Nynex have combined their cellular operations in a \$13 billion joint venture. Pacific Telesis has spun out its cellular operations as AirTouch, leaving itself free to pursue a wireless strategy with a clean slate, using PCS. AirTouch



Table 1
Radio Spectrum Allocations

<u>Service</u>	<u>Frequency Band</u>	<u>Physics</u>
Human Voice	300 - 20,000 Hertz	LOW LONG
AM Radio	535 - 1705 KHz	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> ↓ Frequency ↓ </div> <div style="text-align: center;"> ↑ Wavelength ↑ </div> </div>
Shortwave Radio	3 - 30 MHz	
CB Radio	27 MHz	
TV Broadcasting: Channels 2,3,4	54 - 72 MHz	
TV Broadcasting: Channels 5,6	76 - 88 MHz	
FM Radio	88 - 108 MHz	
TV Broadcasting: Channels 7-13	174 - 216 MHz	
UHF Television	512 - 806 MHz	
Land Mobile Radio	30-50,150-162,450-470 MHz	
Pagers	150, 900 MHz	
Cellular (formerly UHF TV channels 69-81)	825 - 894 MHz	
Specialized Mobile Radio (SMR)	Various 800 & 900 MHz	
Low Earth Orbit Satellites (LEOs)	1 - 3 GHz	
PCS (fixed microwave in this band now, to be relocated)	1.85 - 1.99 GHz	
Geosynchronous Satellites/Microwave	3 - 60 GHz	
Infrared	$10^{12} - 10^{14}$ Hertz	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> ↓ HIGH </div> <div style="text-align: center;"> ↓ SHORT </div> </div>
Visible Light	$10^{14} - 10^{15}$ Hertz	
Ultraviolet	$10^{15} - 10^{17}$ Hertz	
X-Rays	$10^{17} - 10^{18}$ Hertz	
X-Rays and Gamma Rays	$> 10^{19}$ Hertz	

Key:

- 1 cycle = 1 wave peak passing a fixed point
- 1 Hertz (Hz) = 1 cycle per second
- 1 Kilohertz (KHz) = 1,000 Hertz
- 1 Megahertz (MHz) = 1,000 Kilohertz
- 1 Gigahertz (GHz) = 1,000 Megahertz

Frequency in hertz x wavelength in meters =
Speed of light = 3×10^8 meters per second



has subsequently teamed with US West to integrate their wireless businesses in a joint venture. The Baby Bell reunion was capped by the four-way affiliation of the wireless businesses of Bell Atlantic, NYNEX, US West, and AirTouch. Their PCS bidding vehicle is called PCS PrimeCo L.P. Sprint has combined with the cable companies, TCI, Cox, and Comcast, to form WirelessCo, a joint venture to pursue PCS opportunities. MCI at first seemed likely to team with Nextel, but it pulled out at the last minute. It then held discussions with several RBOCs, but in the end it did not conclude a deal and is not participating in the auctions.

Much of this consortium-building frenzy was precipitated by the PCS spectrum auction. Companies needed to leap into the future and try to figure out what the abundance of spectrum and convergence would mean to their long-term strategies. By combining properties before the auctions, the companies were able to spread the business risk around so that no one company was making a "bet-the-firm" decision. Forming the consortia also allowed companies to know in advance where they owned spectrum (cellular), letting them spend their PCS dollars where they had no spectrum.

Charts 1, 2, and 3 show the potential nationwide wireless footprints of AT&T (with McCaw and LIN), PCS PrimeCo and WirelessCo. Included on these charts are the current cellular properties of the operators, showing controlled, noncontrolled, wireline, and nonwireline interests. Layered on top of those current cellular holdings are the MTAs for which they have placed at least one bid in the PCS auction. These are not necessarily where they have the current high bid, but where they have shown interest. What is important to note is that they are trying to expand their cellular territories with PCS licenses that complement their holdings with minimal overlap.

An interesting observation about the form that these alliances have taken is that the major players have structured their partnerships so as to minimize conflict with each other over the markets needed to fill their respective national footprints. Look at New York and Los Angeles, for example. These are "must-have" markets for any national player. The BEL/NYN/USW/ATI group owns spectrum in these

markets through the cellular properties of Nynex and AirTouch. The AT&T group owns it through McCaw and LIN. WirelessCo has Los Angeles through COX's Pioneers Preference award. This teaming up has allowed them to avoid self-destructive bidding for PCS. Some beneficiaries of this alignment are Sprint and its cable partners. With PCS PrimeCo and AT&T not bidding in many of the top markets (e.g., New York, San Francisco) WirelessCo may be able to secure an almost national footprint without having to trump many deep-pocketed bidders.

In Texas, SBC and GTE have negotiated "capacity swaps," whereby they allow each other's customers to use their cellular phones throughout the major markets of Dallas and Houston, as if they were operated by one company. This strategy means that neither of these companies has had to bid for PCS spectrum in Texas, and it preempts other players that may be thinking of taking them on. Together, they present a formidable offense to a third or fourth entrant, without spending anything for more spectrum.

Chicago is a different story. Since the two cellular licenses are held by Ameritech and SBC, which have not teamed up for the auctions, the bidding is the most contentious of all the MTAs.

New Wireless Players May Be Spawned

Going forward, PCS is likely to create some new wireless choices for investors. We may see some ventures like North American Wireless or GO Communications go public in IPOs. Pioneers' Preference winners American Personal Communications and Omnipoint, which are both privately held, may seek capital in the public markets. Letter stock for wireless subsidiaries of major corporations is a possibility, since wireline operators (LECs, long-distance, and cable) may want to enhance the efficiency of stock valuations, or even look for new equity capital.

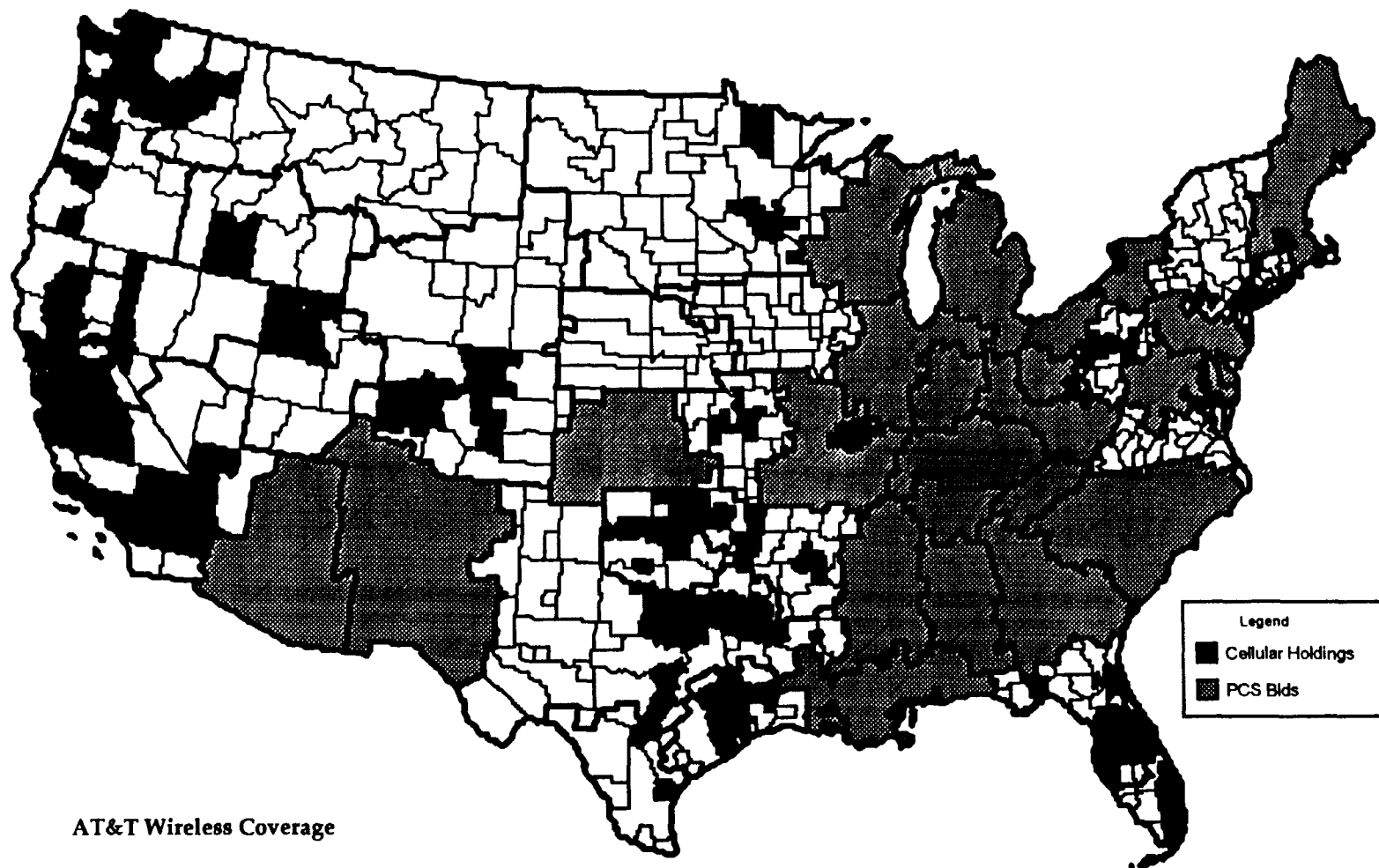
A host of smaller companies is anticipated to be created in the PCS auctions via the Entrepreneurs' Blocks of spectrum, which are set aside for Designated Entities (small businesses and women- or minority-owned firms). A list of these will become available 45 days after the close of the MTA auction, when applications to bid on the Entrepreneurs'

PCS: A Critical Piece of the Communications Puzzle

Chart 1

AT&T Wireless Footprint: Cellular Properties and Possible PCS Properties

Cellular includes control, non-control, wireline and non-wireline properties; PCS Bids indicate MTAs where they have placed bids, though not necessarily the current high bid.



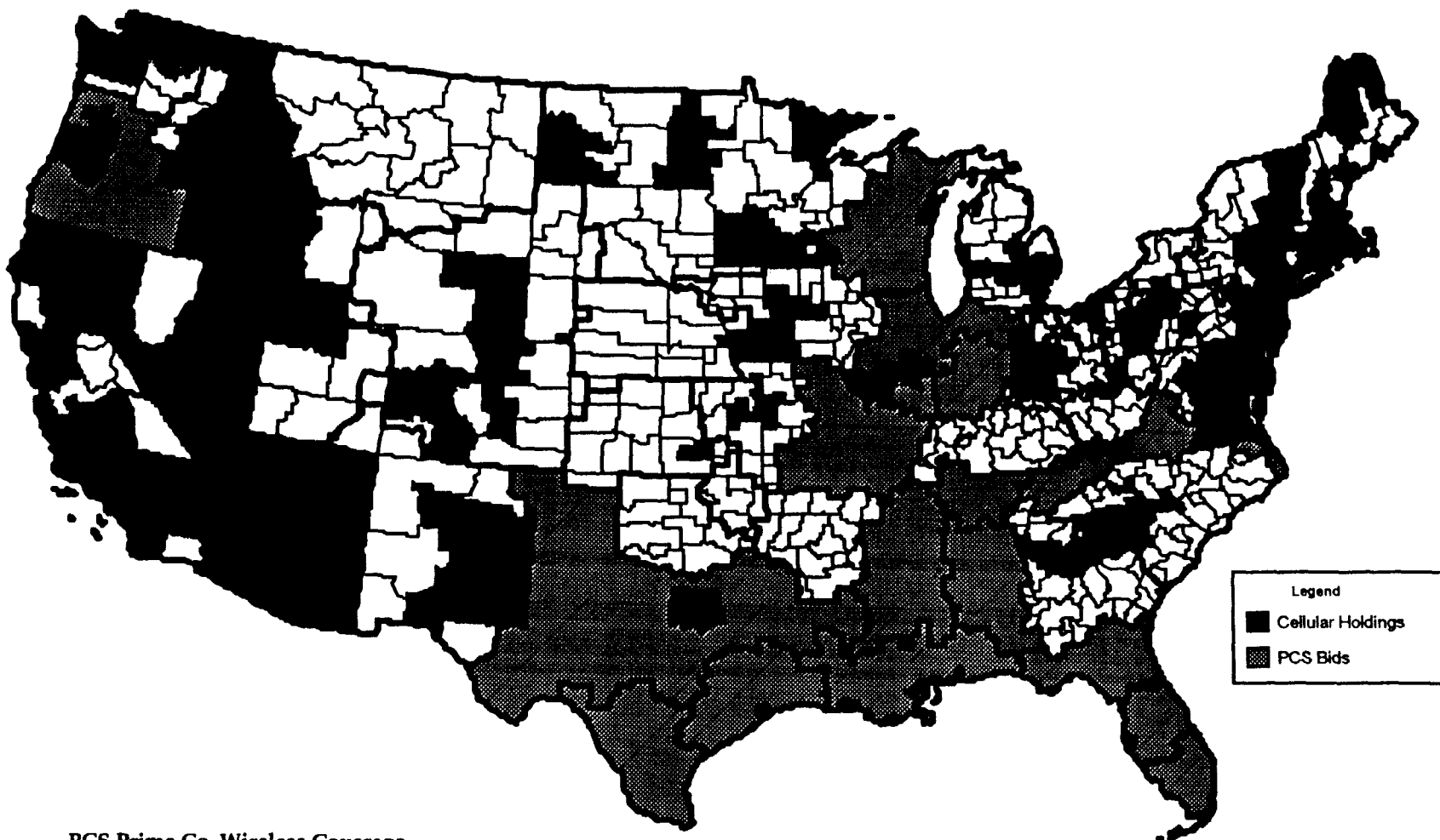
AT&T Wireless Coverage

PCS: A Critical Piece of the Communications Puzzle

Chart 2

PCS PrimeCo (BellAtlantic-Nynex-USWest-AirTouch) Footprint: Cellular Properties and Possible PCS Properties

Cellular includes control, non-control, wireline and non-wireline properties; PCS Bids indicate MTAs where they have placed bids, though not necessarily the current high bid.



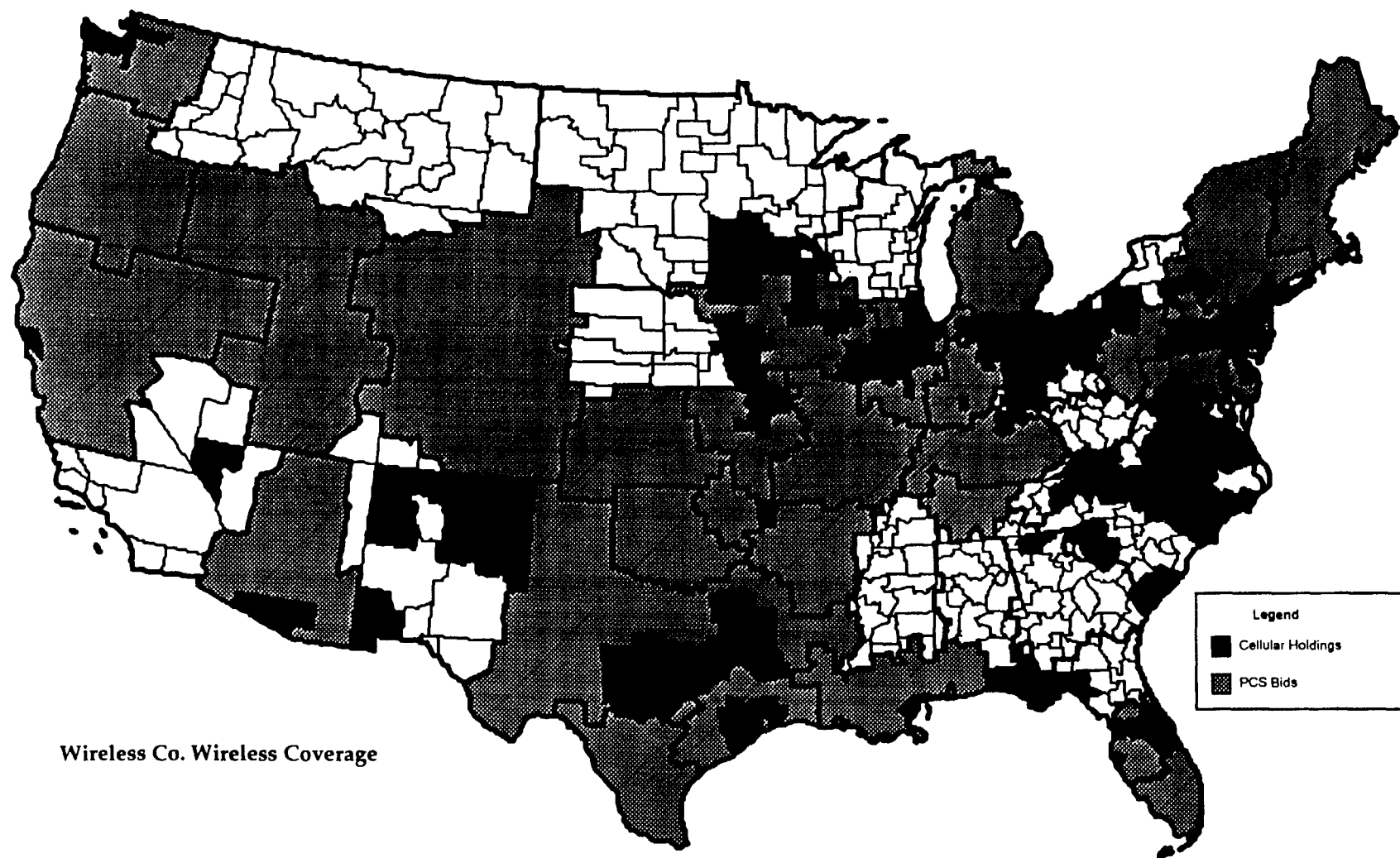
PCS Prime Co. Wireless Coverage

PCS: A Critical Piece of the Communications Puzzle

Chart 3

WirelessCo (Sprint-TCI-Cox-Comcast) Footprint: Cellular Properties and Possible PCS Properties

Cellular includes control, non-control, wireline and non-wireline properties; PCS Bids indicate MTAs where they have placed bids, though not necessarily the current high bid.



Wireless Co. Wireless Coverage

PCS: A Critical Piece of the Communications Puzzle

Blocks must be filed with the FCC. Many of these are funded by private and venture capital. Billions of dollars in capital will be needed to fund spectrum purchase, build-out, and customer acquisition. This money could be debt or equity or both.

We are likely to see the development of a lively secondary market in PCS licenses, similar to that which occurred in cellular. The A,B,D, and E blocks (see "A Background of the Broadband Auction") are free to trade as soon as the auction is over. Swaps of properties across frequencies and geography are to be expected as companies seek to optimize their footprint clusters. For the C and F blocks reserved for Designated Entities, certain restrictions apply to their transfer. Owners cannot sell their licenses for three years. From three to five years, they can sell only to other Designated Entities. From five to ten years, they can sell to anyone, but if they sell to non-DEs, they must reimburse the FCC for the bidding credits they had received. After ten years, the licenses are free to trade without restriction. As we hit these various points, a flurry of transactions will probably take place

The New World View—PCS Will Not Stand Alone

One cannot truly consider the full uses of PCS without considering the changing environment of telecommunications. Today we think of the communications industry as segmented between wired and wireless, voice and video, mobile and fixed. These designations are artificial, and more the result of regulatory and legal issues than economic and technological reality. The transformation into a seamless communications environment has started, in which consumers will be able to obtain the full range of services from a single vendor, but with a choice of who that vendor is. In the fullest form of development of this environment, no natural monopolies exist.

With this in mind, success in the communications industry will rest on two primary factors—effective packaging of services and direct access to/control of the end user. The package of services that successful vendors must offer will include wireless and wired voice, data, interactive services, and wired video. This is the essence of convergence. Wireless video will probably have to await further advances in the silicon world.

To be concrete, let us consider some examples of how this new world works. An easy one to imagine is a local exchange carrier fulfilling this role. The LEC will obviously be able to offer local voice service. It will also be able to offer local video services, assuming, of course, deployment of broadband networks. Furthermore, within a reasonable time frame, the LEC will be allowed to integrate its wireless into its wired service offering (from a marketing and operating perspective). Finally, once regulatory restrictions completely fall (by decade's end), long-distance services can also be offered—and the full package will have arrived. This same end will be pursued by the cable companies, assuming the success of the consortium with Sprint.

Long-distance carriers will also be in the game. Their roles are not quite as obvious, however, since we do not think of them as possessing local service capabilities. However, the brave new world of communications will not allow this to be an obstacle. We believe that local service providers, whether wired or wireless, will be mandated by law to operate as common carriers, meaning resale of capacity will be required. What this means is that even if a long-distance operator does not build its own local service facilities, it will be able to resell the facilities of others to connect directly to end users. In the future, there will be several local distribution companies (i.e., CAPs, LECs, cable companies, and wireless operators), all competing to provide the long-distance companies with access to the customer.

Take AT&T as the example. AT&T will enhance its long-distance network capability to offer local switching. In addition, it will aggressively build its wireless access capability through McCaw, LIN, PCS licenses, and probably, capacity swaps with other carriers. Finally, in order to access local wired facilities and provide the full panoply of services, AT&T will, in most locations, resell the local loop of LECs, cable operators, and alternative-access providers. Thus, a long-distance carrier, without an ownership stake, or even strategic partnership with local distribution companies, will be able to offer all the necessary services.



What is the relevance of this description of the "new world of communications" to PCS? It is that *we do not believe investors should think of PCS as a narrowly defined, stand-alone service*. First of all, soon after its introduction (within five years), it will probably not be discernible whether one's wireless service is being provided at 850 MHz (cellular) or 1900 MHz (PCS). Secondly, as a mass-market service, it will be packaged with other communications services.

Thus, we do not view PCS as a unique development to be understood in isolation. It will be interwoven with existing communications services. PCS will be a facilitator of convergence. It will allow providers to knit together their existing facilities in such a way that the consumer perceives a seamless product offering. Consumers will not care about the technology behind the applications they use; they will just know that the phone works wherever they are, or that the images they want to view are available at their pleasure.

The Implications of Convergence and Abundance

The marketing of wireless as part of an integrated service package (i.e., convergence) has vast implications for industry development, and more specifically, for the valuation of PCS licenses and existing cellular businesses. A second major concept that needs to underpin any evaluation of wireless is the abundance of spectrum/capacity. The combination of these two factors changes the nature of wireless from what we have known over the past ten years to something entirely new. *In fact, our major theme in analyzing the wireless industry is the notion of convergence of services combined with abundance of capacity.*

Owning a wireless license will not be a license to print money, the way it essentially became in cellular. *The allocation of a lot of new spectrum eliminates the scarcity value of the license, and puts supply and demand in better balance.* This is a basic shift from the cellular model, in which duopolies were established, and capacity was constrained. Can anyone think of a failed cellular company? Certainly not every cellular company is equally talented, yet they all seem to have succeeded. Nearly all produce strong cash flow, and are highly valued in the market. The demand for the service and the limited options customers enjoy have essentially made all service suppliers successful.

Not so in the new world of telecom, wireless, and PCS. What are the implications of convergence and abundance? *First, owning a license does not guarantee success. Second, success will be contingent on being able to combine wireless with other communications services, and being able to run businesses competitively.* Ingredients of success will include: marketing clout; networking talent and efficiency; economies of scale in operations, management, and marketing; capital availability; strong brand name; and speed to market. An existing customer base can also be very important. Clearly, there are other elements of success, but we think these are the key items.

These elements of success do not preclude startup ventures or small entrepreneurial business, but they certainly raise the hurdles. We think the smaller companies that enter this business through the acquisition of licenses in the auction will have to either be extraordinarily good at putting together all the necessary pieces of the puzzle or exploit "symbiotic" relationships with larger entrenched players.

The Demand for Wireless Communications

Given our view that PCS will be an integrated piece of the overall communications pie, we return to the question of why it has such value for the bidders in the auction. The answer really comes down to the customer. Customers want communications services that are easy to use. They want mobility and functionality. Cordless telephones and cellular proved this in spades. They want one bill and one customer service center to call with problems. Basically, they are demanding the ability to communicate in ever more convenient ways. This is not a fad.

Thinkers throughout history have identified the need to communicate and interact as a basic human instinct. The English author John Donne wrote, "No man is an island unto himself." The psychologist Abraham Maslow identified a theoretical hierarchy of needs, chief among which is *affiliation*, a basic human need, just above food, clothing, and shelter. In today's world, this human need to interact is manifested in the demand for communications services. The hope of PCS providers is to mine this powerful vein in human behavior.



PCS: A Critical Piece of the Communications Puzzle

Table 1
Wireless Subscriber Forecast

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total US Population (millions)	250.0	252.5	255.0	257.6	260.2	262.8	265.4	268.0	270.7	273.4	276.2	278.9	281.7	284.5
Total Wireless Penetration	3.0%	4.4%	6.3%	9.2%	13.0%	16.5%	19.4%	22.4%	25.5%	29.2%	33.1%	37.0%	40.9%	44.6%
MARKET SHARES														
Cellular	100%	100%	100%	100%	100%	99%	98%	95%	92%	88%	83%	80%	76%	74%
PCS	0%	0%	0%	0%	0%	1%	2%	3%	6%	10%	15%	18%	21%	24%
ESMR	0%	0%	0%	0%	0%	0%	1%	1%	2%	2%	2%	2%	2%	3%
PENETRATION														
Cellular	3.0%	4.4%	6.3%	9.2%	13.0%	16.3%	18.9%	21.4%	23.5%	25.6%	27.6%	29.5%	31.3%	32.9%
PCS	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.8%	1.6%	3.1%	4.8%	6.7%	8.6%	10.5%
ESMR	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.6%	0.7%	0.8%	1.0%	1.1%
SUBSCRIBERS (millions)														
Cellular	7.6	11.0	16.0	23.7	33.8	42.9	50.2	57.2	63.5	69.9	76.2	82.3	88.0	93.6
PCS	-	-	-	-	-	0.3	0.8	2.0	4.4	8.4	13.4	18.7	24.3	29.9
ESMR	-	-	-	-	0.0	0.2	0.4	0.8	1.2	1.5	1.9	2.3	2.8	3.2
Total	7.6	11.0	16.0	23.7	33.8	43.4	51.4	60.0	69.2	79.8	91.5	103.3	115.2	126.8
SUBSCRIBER GROWTH RATE														
Cellular	NA	46%	45%	48%	43%	27%	17%	14%	11%	10%	9%	8%	7%	6%
PCS	NA	NA	NA	NA	NA	NA	200%	159%	120%	88%	60%	40%	30%	23%
ESMR	NA	NA	NA	NA	NA	413%	138%	88%	50%	30%	25%	23%	20%	16%
NET SUBSCRIBER ADDITIONS														
Cellular	NA	3.48	4.98	7.69	10.09	9.13	7.30	7.03	6.30	6.35	6.29	6.10	5.76	5.55
PCS	NA	0.00	0.00	0.00	0.00	0.26	0.52	1.24	2.43	3.91	5.02	5.35	5.62	5.60
ESMR	NA	0.00	0.00	0.00	0.03	0.14	0.24	0.36	0.39	0.35	0.38	0.44	0.47	0.45
Total	NA	3.48	4.98	7.69	10.12	9.53	8.06	8.63	9.11	10.62	11.68	11.88	11.84	11.59
SHARE OF NET ADDS														
Cellular	100%	100%	100%	100%	100%	96%	91%	81%	69%	60%	54%	51%	49%	48%
PCS	0%	0%	0%	0%	0%	3%	6%	14%	27%	37%	43%	45%	47%	48%
ESMR	0%	0%	0%	0%	0%	1%	3%	4%	4%	3%	3%	4%	4%	4%



We cannot quantify the total demand for communications services. Two hundred years ago, before electronics and radio, estimates of communication demand would encompass newspapers and mail, not to mention lamps in the belfry of the Old North Church. We would totally miss the untapped demand, which people did not realize existed. Once the telegraph and telephone were invented, we would have included those media in our estimate. However, we would still be missing demand for things like faxes, e-mail, paging, etc.

The point is that demand appears to grow based on the ability of technology to facilitate human communication. If the means are devised, people will utilize them, and utilize them for things that had not even been thought of before. Demand expands to fill the available space. New methods of communication will stimulate incremental demand for communications, not just cannibalize existing demand.

The phenomenal growth of cellular and paging services has outstripped even the most optimistic forecasts. Cellular telephony only began in earnest ten years ago, and today, there are 25 million subscribers, with 27,000 being added each day. The paging industry now has 24.5 million subscribers, with yearly growth running at close to 30%. Two out of every three new phone numbers being assigned in the United States are now for a wireless device. It is statistics like these that cause wireless companies and investors to salivate.

Estimates of Wireless Subscribers

To get a rough handle on the size of the market we are talking about, we went through the exercise of forecasting the number of subscribers for the three main spectrum blocks that exist: (1) cellular—50 MHz in the 800 MHz band; (2) PCS—120 MHz in the 1.9 GHz band; and (3) enhanced specialized mobile radio (ESMR)—10-15 MHz in the 800-900 MHz band. (In this report, we do not address the narrowband area of PCS—i.e., paging and messaging, but this is area of future discussion and interest for us.)

We present our results in Table 2 and in numerous charts as a starting point for discussion. We have made educated estimates and evaluated them for

reasonableness in the context of growth rates, penetration, and market share. To be sure, much uncertainty surrounds the ultimate subscribership that can be expected, and the timing thereof, but we think that putting a few stakes in the ground is necessary to further the discussion. One should envision a band of plus or minus 10-20% around our estimates to get a range of possibilities. Also, it is important to keep in mind that over the next ten years, we do not expect wireless to be sold as a stand-alone service, but rather, as integrated with other communications offerings. Second, the dominant suppliers of wireless services will be the same players that are dominant today (with the probable exception of the cable companies teaming up with Sprint). So distinguishing between PCS and cellular market share can be a bit misleading, since the same companies will be using both.

Chart 4 shows the estimated growth rates in new subscribers for the three spectrum positions. Cellular, which has been growing at a rate of 45-50%, is expected to see its growth rate decline as both the base increases and the growth of net additions slow. Note that cellular growth really starts to slow at the time that PCS and ESMR come on line, as we would expect with the introduction of competition. Beginning in 1996, we estimate a high growth rate in ESMR, since the base is negligible. The rate drops off significantly after 1996, then moderates in the 20-30% range after 2000.

This reflects our thinking that ESMR will have to target a market segment of mobile service workers, such as the 15 million SMR and two-way radio users today. Our forecasts assume that ESMR will capture 20% of this market by 2004. It will not be the mass-market mobile service envisioned by its original proponents. We do not see ESMR as having the cost structure or spectrum to effectively penetrate the consumer cellular market.

PCS (i.e., mobile communications operating at 1.9 GHz) growth is expected to start high, then moderate. However, four years of triple-digit growth is nothing to sneeze at. Chart 5 shows the numbers of subscribers forecast by our growth rate estimates.

PCS: A Critical Piece of the Communications Puzzle

Chart 4
Estimated Annual Growth Rate in Subscribers

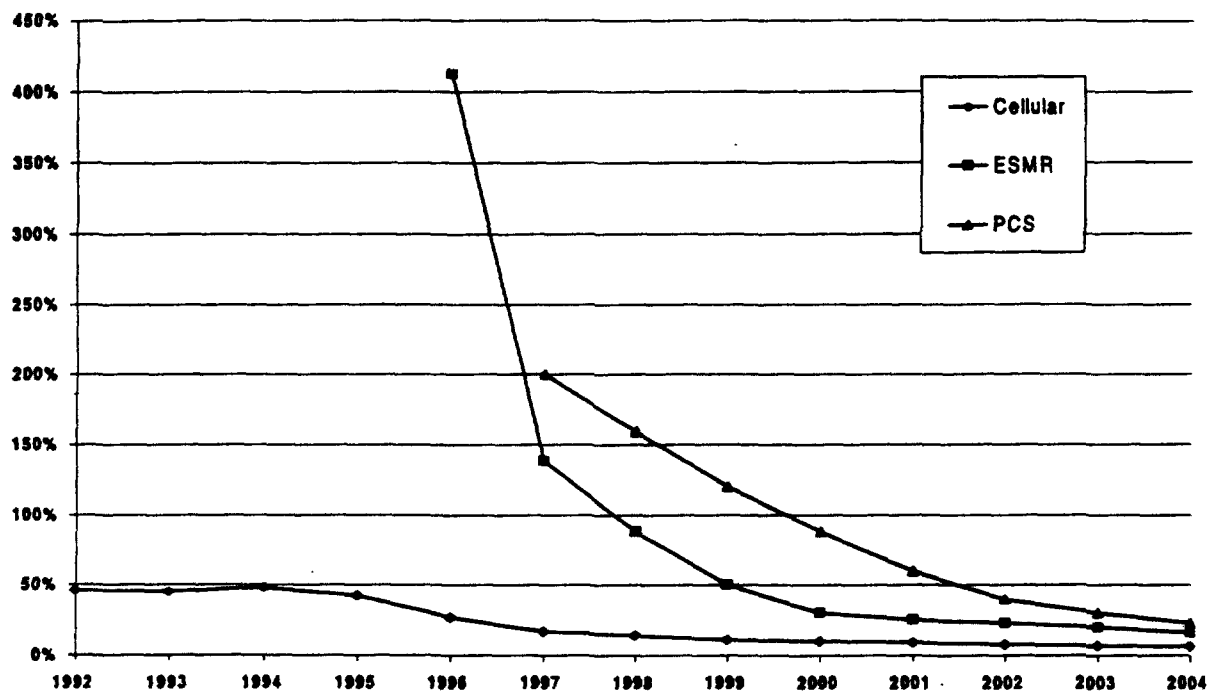
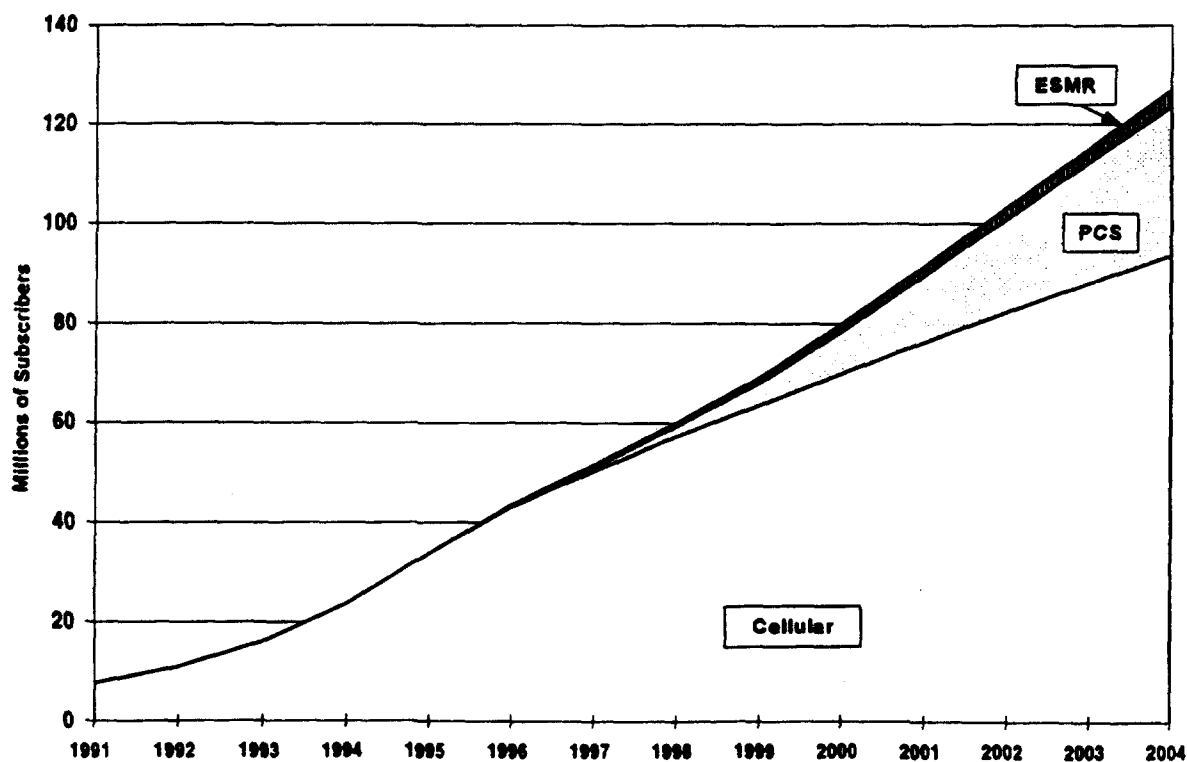


Chart 5
Estimated Number of Subscribers



PCS: A Critical Piece of the Communications Puzzle

Chart 6
Share of Net Subscriber Additions

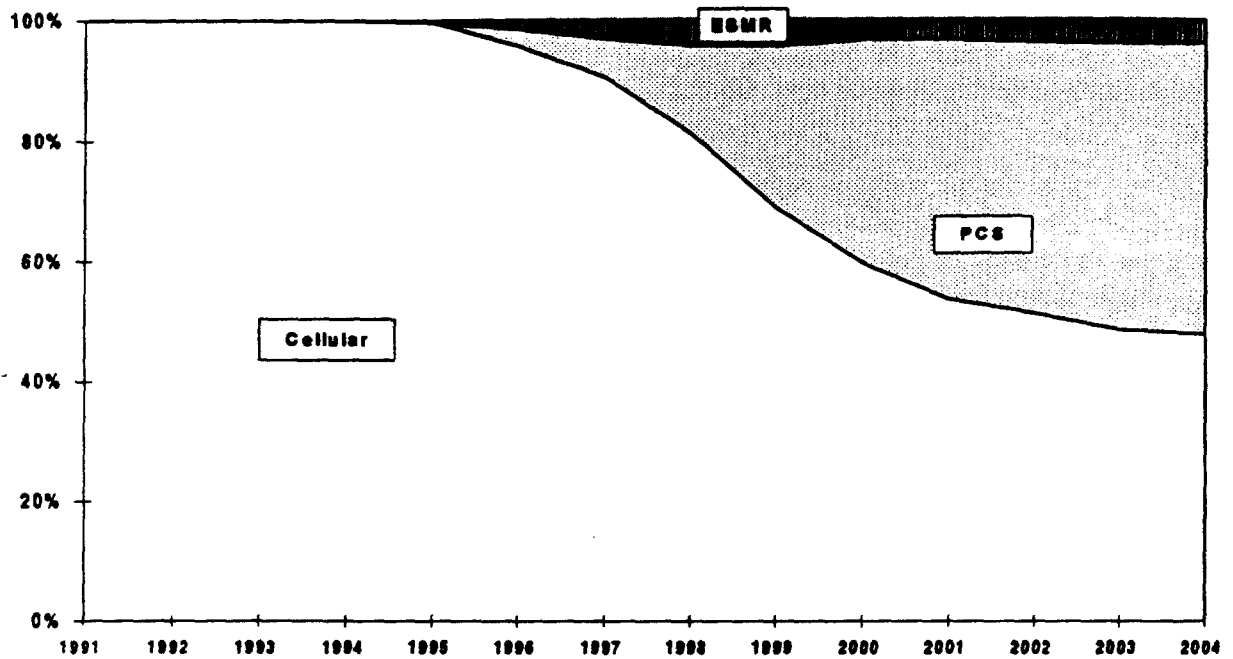
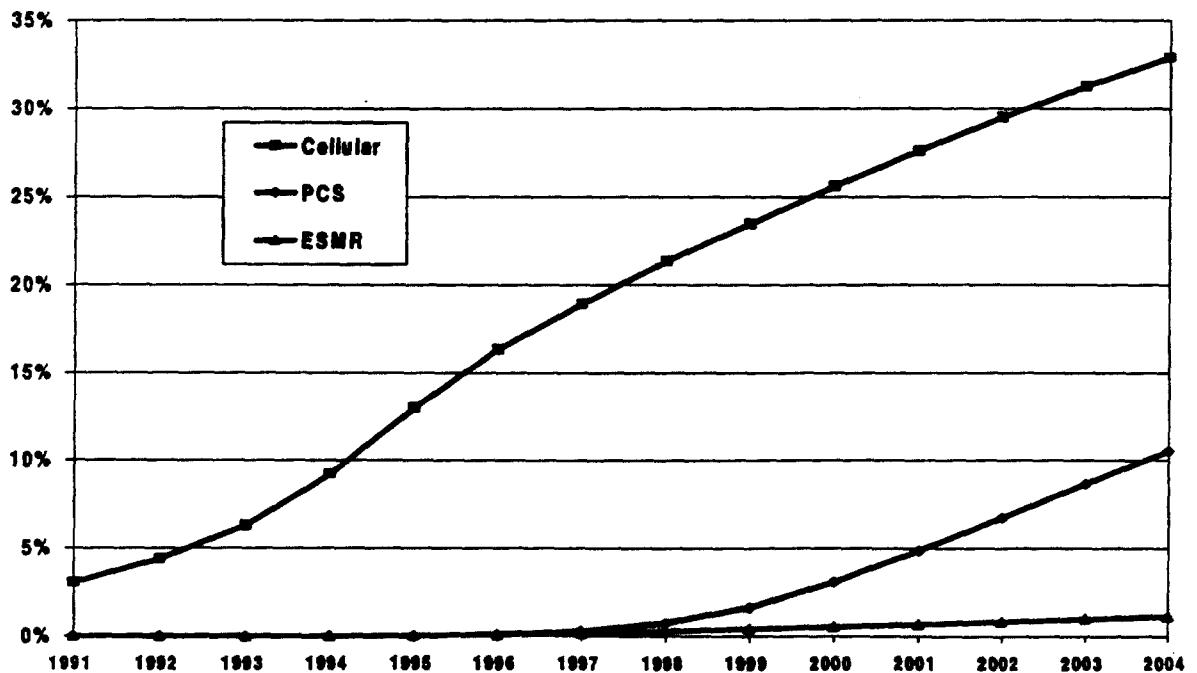


Chart 7
Estimated Penetration Rates



PCS: A Critical Piece of the Communications Puzzle

Notice how the PCS wedge really opens up in the out years. Chart 6 shows what these numbers of subscribers mean in terms of share of net additions. The key takeaway is that PCS will represent almost half of the new subscribers to wireless, starting around the year 2000. Its total subscriber level is estimated at around 30 million by 2004. By comparison, cellular had 20 million subscribers after ten years in service. The logic in this strong performance for PCS is that at 1.9 GHz, there will be tremendous capacity available, and the current industry giants that intend to employ it will drive growth aggressively. In addition, new entrants to the industry must, by definition, rely upon this frequency band.

The penetration rates implied by these figures are graphed in Chart 7. In ten years, cellular is at 30-35%, PCS at about 10%, and ESMR at just 1%. PCS is really ramping up at this point, and in absolute terms, is adding more subscribers per year than cellular.

The Concept of Telecom Space

These charts give a somewhat distorted view of what we think is likely to evolve. Discrete division of subscribers along spectrum-usage lines (cellular, PCS, ESMR) is probably not a distinction that will hold up over time. To help understand this point, refer to the four Venn diagrams in Chart 8.

Each panel represents a snapshot in time of *subscriber sets* in what we call *telecom space*. In 1980, the only significant subscriber set was wireline. Cellular operations had yet to begin, and telecom demand was met by wireline. By 1990, the cellular subscriber set had begun to grow. We reason that cellular subscribers are a subset of wireline. Cellular subscribers did not do away with their wireline telephone; rather, they added a cellular phone and paid two bills. They probably used the wireline phone less, but did not do away with it entirely.

By the year 2000, PCS and ESMR subscriber sets will begin to develop. These sets are not drawn to scale, as scale is not important to this discussion. *Understanding the overlap of sets is the critical concept.* By 2000, there will be a variety of appliances that can operate from macro wireless networks, in-building microcell facilities, and wireless base stations on customer premises, which in

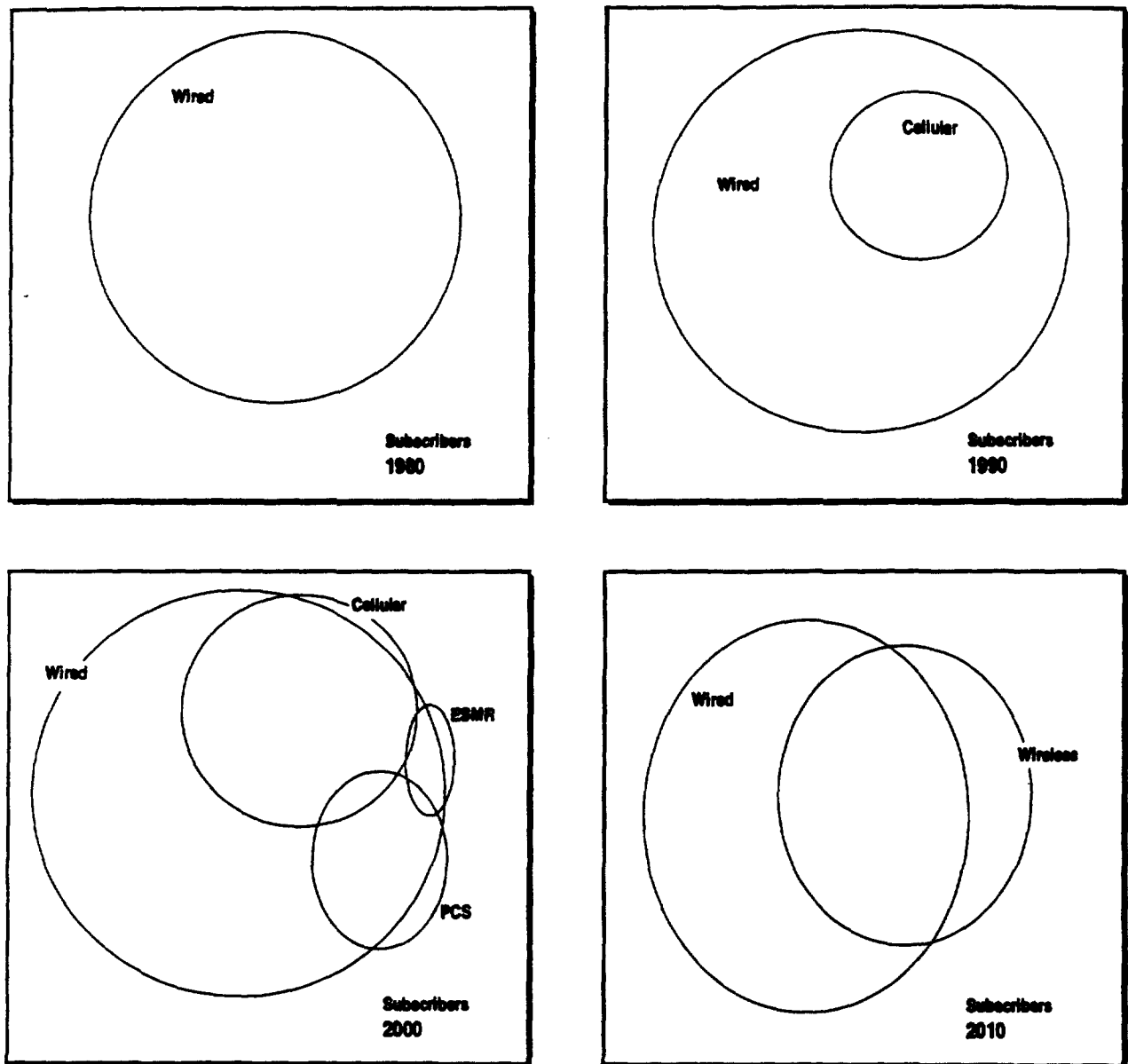
turn, operate from the landline networks. A subscriber to these services can get one bill. What do we call him? A PCS sub, a cellular sub, or a traditional landline/cable customer? He falls into several categories simultaneously. The point of contact for the customer may be just one company, which he chooses from among several in the market, but the services used may cross several sets in telecom space.

In the year-2000 panel, the wireless sets start to egress from the wireline set. Some subscribers will begin switching service suppliers, perhaps dropping their wireline telephone service, and selecting a communications package offered by a cable company or long-distance carrier. Some, who do not want a whole variety of services, may drop their wireline connection altogether, and rely solely on a wireless connection. *By the year 2010, we hypothesize that the distinction between frequencies will be so blurred that we combine the sets together into a generic wireless set, which is moving still further away from the wireline set. If we are correct in our thinking about the integration and overlap of wireless categories over time, forecasts of individual subscriber sets become an exercise in futility.*

Segmentation of the Wireless Market: Divide and Conquer

The major radio spectrum positions are the raw material for wireless companies. Different frequency bands have different propagation characteristics, but for the time being, let us assume they are a fungible resource. The game for wireless entities then becomes: What do I do with my spectrum? Different owners of spectrum will use it differently. Large, national communications companies, like AT&T and Sprint, will use it in ways in which large regional companies, like BellSouth or SBC Communications, might not. Certainly, startup companies, entering the wireless business for the first time, will have entirely different approaches to the market. So, as we describe segmentation and marketing strategies here, it must be emphasized that this market is not monolithic, and that there may be as many strategies as there are companies possessing wireless licenses.

Chart 8
Telecom Space
Not to Scale



We expect that the wireless business will evolve into a broad lattice of service offerings targeting specific market segments. This is already evident today. CB radio focuses on a low-end segment of wireless demand. It fills a need. Services for transmitting data from mobile units, such as delivery trucks, are offered in many areas. Push-to-talk SMR focuses on the fleet-dispatch segment. Cellular is just another segment, albeit the biggest and most familiar. Its service is a generic, voice-oriented offering, which has the broadest appeal of all. Paging services today are broken into local, regional, and national price plans, with a choice ranging from simple numeric pagers to alphanumeric messaging devices. Each offering targets a segment of users.

Looking into the future, the segmentation will become even more specialized, as companies seek to earn back their investment in spectrum. Narrow niches will abound. Devices for doctors to remotely diagnose patients may be invented. Telemetry equipment for trucks and trailers will target transportation customers. Monitoring gear for vending machines or oil wells will summon service representatives only when needed, eliminating routes and saving money. Use your imagination. There are so many needs for information that can conceivably be filled through the segmented use of wireless services.

The vision of a segmented marketplace is not inconsistent with our premise that wireless will be offered to consumers as part of an integrated package of communications. A wireless niche operator that optimizes its spectrum and infrastructure resources around a specific function will find that packagers will want to resell that service under their brand names. Picture a large, branded company marketing to customers with a smorgasbord of services bundled together. For a certain price, the consumer can choose one from column A and two from column B. While ideally, the packager may wish to offer all services using its own facilities, the practical reality is that the big, national players will initially focus their efforts on the mass-market, two-way voice functions where the biggest revenue potential lies, such as cellular- or local loop-type service. Smaller players, like the Designated Entities, will carve out the niches, marketing them directly to consumers or reselling them through national players.

One Target Segment for PCS: Mobile Telephones

Mobile telephone service is the obvious use that PCS spectrum winners will target. Surely we will see "me-too" cellular offerings, hoping to capitalize on the stupendous customer demand for cellular phones. Certainly, to the extent that the current service suppliers fail to meet demand, this strategy can be successful for a period. However, there are hurdles to this becoming a major long-term investment opportunity. The incumbent cellular operators do a pretty good job of meeting the demand for mobile communications that exists today, and they certainly will migrate to the integrated communications offerings we wrote about earlier. A PCS provider hoping to go up against cellular with a me-too product will have a long, tough row to hoe. *Two near-term strategies PCS players may try against cellular are offering a similar product at a lower price or, conversely, offering a better product at the same price.*

Same Service, Lower Price

Let us look at the first possibility, same product, but cheaper. The nature of PCS spectrum, namely higher frequencies and lower-powered signals, means that more cells are required to provide coverage similar to cellular quality. Whereas a cellular cell may be 10 miles in radius, a PCS cell is more like 5 miles. Therefore, it could take up to four times as many PCS cells to cover the same terrain as one cellular cell in a hypothetical, flatland topography. In densely built, hilly, or heavily populated areas, these radii must decrease dramatically to overcome shadowing, increase frequency reuse, and get the resulting capacity increases. These factors could drive PCS to use many more than four times as many cells as cellular.

The expense of more cells is mitigated by the lower cost of PCS cells relative to cellular cells. What is not definitively clear is whether the *total* cost of covering a given terrain will be higher or lower than cellular. At the recent CTIA convention, we quizzed equipment suppliers for an answer, but the most frequent response was, "It depends," followed by a litany of variables. However, common sense tells us that in low population-density, rural areas, the need to employ many more cells, probably on several hundred-foot-high towers to get decent range, would make the economics of "me-too" 1900 MHz mobile phones less favorable than

those of 800 MHz cellular. Therefore, we do not expect to see "more cellular" offerings in exurban areas anytime soon.

In urban areas, it is not as clear whether cellular has a construction cost advantage over PCS. Constellations of inexpensive PCS microcells deployed at low heights on building rooftops and light poles would alleviate the need for expensive towers and land. The revenue potential is also higher, given the greater population density. Therefore, cellular-type service will likely be offered, especially in cities like Los Angeles, New York, and Chicago, where demand for mobile phones is outstripping the capacity of the analog cellular networks.

Setting the relative construction costs aside, many cellular operators received their spectrum free, and do not have to price their service to recover that cost. When the two cellular licenses in each region were distributed in 1982, the local wireline telephone company was given one, and the other was given to a nonwireline entities, following hearings and lotteries. Most of the current cellular operators acquired licenses subsequent to the original grants, somewhat leveling the spectrum-cost playing field with PCS license holders that will enter their markets. However, there is a great deal of variability in this regard. For example, companies like Ameritech, NYNEX, and US West have completed virtually no domestic acquisitions (US West is swapping out of San Diego), while AT&T has acquired more than \$20 billion of cellular assets..

As PCS license holders start their service rollouts, do not expect cellular operators (which will undoubtedly be PCS operators in other markets) to sit on their heels. First of all, keep in mind the ability to bundle services over the next three to five years, which will help the incumbents create attractive integrated packages. Second, think of the advantages of embedded customer base, plant, marketing and distribution channels, and experienced engineers and managers (of which quality ones are always in short supply). Then, of course, PCS will have to match or beat existing prices, just when the deployment of digital should allow capacity expansion that facilitates lower prices. With the mature players in the cellular industry achieving 40-45% operating cash flow margins, they have room to retaliate on price. However, it is not only price where cellular can defend its business. It has a 13-year head start in infrastruc-

ture. It will add more coverage, always striving to stay ahead of PCS in terms of footprint size. After price, customers compare operators on the size of the "home service area" in which they do not have to pay higher roaming rates.

Cellular will utilize the enormous embedded advantages it enjoys to protect its business. It controls the most important distribution channels already. For PCS to break into these channels, it will need to either buy its way in or develop cheaper, more innovative ways to acquire customers. Bear in mind, the big players in PCS are the big players in cellular. If some new, cheaper way to market the service is devised, cellular should be able quickly to copy it. Yet another hurdle for PCS is that cellular's large customer base is already generating positive cash flow. PCS will not see positive operating cash flow for a few years after startup. *Given these considerations, providing service at a lower price than cellular will be a difficult challenge.*

Better Service, Same Price

Now, let us consider better service at a similar price. PCS may be able to claim a *universally* better quality of signal, as it will be 100% digital from the start, whereas cellular is still predominantly analog. However, that advantage should be minor, as cellular operators will seek to build sufficient digital to meet capacity demand and preserve the quality of the analog channels. Also, there is not a huge clamor in the marketplace for *digital*-quality mobile service today, only better-quality service. Privacy issues are often raised about analog cellular, but few subscribers with whom we have talked really care if someone can tap into their calls.

Where the digital advantage can really come into play for PCS is in increased capital efficiency, yielding more capacity for less investment. Digital transmission technologies will allow four to 20 times the traffic of analog cellular, depending on which standard is employed (and which manufacturer is to be believed). If PCS is to make its way into the typical cellular customer base, delivering more minutes for less cost may be the answer. This would only be a time-to-market advantage, though, since digital upgrades to existing 800 MHz cellular are starting to deliver the higher capital



efficiency. *All in all, we think that a strategy of providing better service at a similar price provides short-lived advantages to PCS.*

Same Service, Same Price

In the grand scheme of things, what is likely to develop in the battle for the in-car mobile telephony customer is several competitors offering nearly indistinguishable services. The telephone handsets will be basically the same. The functionality and geographic operating territories will be very similar to today's cellular duopoly. In effect, the basic unit of service, a minute of airtime, becomes commoditized, unless, of course, companies learn how to differentiate on a basis other than price. This is where bundling of services, marketing, and leveraging an existing base of business become critical.

As with other commodity-type businesses (long-distance comes to mind), branding is an important differentiator of one's product from all the other choices available to the consumer. In telecom, according to market research, the biggest brand name is AT&T. In fact, before its acquisition of McCaw, AT&T usually turned up in consumer surveys as the second- or third-most recognized cellular service provider and handset vendor, even though it did neither. Sprint also has a widely recognized name, and the strategy of its consortium with the cable companies is to leverage cable's infrastructure with the Sprint brand. MCI's strategy of reselling other players' wireless capacity, rather than building its own facilities, is the purest example of a company using its brand equity to compete. The Baby Bells also have very strong brand names within their respective service territories.

Given the barriers to entry for a third or fourth provider of a me-too cellular-like service, spectrum winners will have a fight on their hands to secure a toehold in this segment. *Our conclusion is that the incumbent cellular operators have a strong advantage, which will hold for several years over new PCS license holders (including PCS license holders that happen to be cellular-incumbents in other markets). As we get closer to the turn of the century, successful operators will be those that have packaged their wireless services most successfully with other communications services, are strong operators, and possess strong marketing capability.*

Another Target Segment for PCS: The Local Loop

Many observers believe that ultimately, wireless access into the national telecom (wired) network will compete directly against wired access. To date this has not occurred for a variety of reasons, but some who are staking fortunes on PCS bids believe it is inevitable in the future. We agree that over the next five to ten years, wireless connectivity will become an important subset of the wired connection. However, we are not as aggressive in believing that, just because wireless access may be cheaper over the long run than copper wire, this means the demise of the wired local loop. Clearly, wireless access will cannibalize wired access, but we do not believe it will take a dominant share of the business.

Why do we believe in the survivability of the wired local loop? Because we are convinced of several trends in the telecom industry. First is the intensification of competition in the local loop; second is the deployment of broadband capability in the local loop; and third is the need for communications service suppliers to be able to offer a full complement of services.

Why would more local competition aid the survival of the wired local loop? Basically because no one should believe that the local exchange industry is like a deer frozen in the headlights of an oncoming car. Everything about this business is changing, and the companies are too. Competition will inevitably drive down access charges and toll rates, redistribute the universal service subsidy among all service suppliers, and cause the local exchange carriers to cut costs. All of these may not make the wired connection cheaper than wireless access, but it probably does not have to be cheaper to survive. The reason for this is that the local loop is making the transition from a slow-speed, narrowband connection to a high-speed broadband connection for many, if not most, parts of the country. Once a broadband loop connects customers to the local exchange carrier, the dynamics of the cost comparison with wireless become irrelevant. The incremental cost of a voice call over a broadband link is next to zero, and based upon the utilization of the network, it may be priced close to zero.

The third and most important reason we believe that the wired local loop will survive goes back to one of our basic tenets, the need for successful communications companies to be able to offer a vertically integrated package of services. Thus, a local phone company, a long-distance carrier, and a cable company will each have to offer all forms of connectivity; otherwise, we do not believe they will be successful over the long run. Technological developments will allow customers to use a phone in the home that operates over the local wired network (be it cable or telco), and when they leave the home (or an immediate calling area), the phone will access an external wireless network (at either 850 or 1900 MHz). GTE's Tele-Go does this already, and we suspect others will develop similar products.

If the LECs Are Adapting, What Is the Local Loop Opportunity?

The opportunity for invaders of the local loop is to provide a service that satisfies a need. An obvious comment, right? Not really. For example, a small player that ends up with a PCS license may find that its opportunity is to facilitate the development of wireless access as a wholesaler. Thus, in locations where long-distance carriers fail to win licenses, or do not even bid (i.e., MCI), this company can offer the wireless local loop part of the long-distance carriers' full-service portfolio. Alternatively, there will certainly be some segment of the market that chooses to yank out its tried-and-true twisted pair, or even coaxial cable, in order to be fully untethered, and the carrier must be prepared to satisfy this customer's needs.

The market opportunity in the local loop, therefore, is real, but sizing the market is difficult. Local exchange carriers collect about \$115 billion annually. About \$28 billion of this is for access charges. Toll calling represents another \$12 billion of the market. Local service is about \$48 billion. The remaining \$27 billion is comprised of cellular, directories, international, and other services. Local service, the largest segment, is flat-rate in much of the country, and almost none of the carriers make money providing it. Rebalancing of rates, which will inevitably occur in the future, may make this business profitable, but more likely, the subsidy that is embedded in access charges, business service rates, and toll rates, which support universal low-cost phone service, will be more broadly redistributed, and will not find its way back just to local service. Access charges

are bound to decline by about 50% over the next five years, and toll service revenues are not likely to rise much, if at all, over the next five to ten years.

Clearly, the opportunity for wireless providers will be first of all a niche opportunity: First, pick off the best customers, who can be profitable in local service and tolls. Second, pick off some portion of the interexchange access market, which, while declining, will still provide a profit opportunity. With alternative-access providers—direct wired access provided by long-distance carriers' resale of the LEC's local loop, all vying for a piece of this access business, one should not assume this particular opportunity is a lay-up.

The bottom line is that, as with all elements of the communications market, competition in the local loop will be just that, competitive. Thus, a PCS service provider that wants to compete for this business must have an angle. We think the angle must be to offer a better bundle of services either alone or in consortia with other communications suppliers. Do not forget, however, that the LEC will also offer a bundled service, as will long-distance carriers and cable operators. So again, success will demand many things, including: good packaging; low cost; effective marketing; high-quality, ubiquitous service; being early to market; and so on.

How Will the LECs Compete?

The LECs will fight hard to protect what has been their exclusive domain for 100 years, not only against wireless upstarts, but also against alternative-access providers, cable companies, and long-distance carriers. They have a lot of infrastructure in the ground that will help their defense. They have very deep pockets. Some are conducting tests of wireless local loop-type services using cellular spectrum. Bell Atlantic has a service called PCS Now, and GTE has an offering called Tele-Go. The common thread is an enhanced cordless telephone that is billed close to wireline phone service when used in a small geographic zone, but that allows roaming into broader territories at a higher per-minute rate, more like cellular. The goal of the LECs is to have a competitive offering when PCS local loop upstarts come calling on their customers.

The wireline network has a capacity advantage over wireless. Local service is often offered at flat rates, regardless of traffic volume. It will be years before



a wireless service will have the capacity to handle the demands of America's teenagers hanging on the phone all night long.

It is often assumed that the 80/20 rule applies to the local telephone business. Namely, 80% of the business comes from 20% of the customers. These are the heavy users of telephone minutes, and wireline will likely retain the cost advantage in providing that service within the business environment. (The LECs already face some competition for these customers from competitive-access providers like MFS and Teleport, and this will soon expand as switched-access competition is authorized by state regulators.) The other 20% of the business that comes from 80% of the customers is where the wireless local loop could make inroads. These are low- to moderate-usage customers who will not overload a wireless network's capacity. However, the opportunity will depend largely on how subsidies are redistributed in the industry. Low-use customers do not make many long-distance or toll calls, and therefore, are generally not terribly profitable. However, if these customers are big cable subscribers (which is often the case), a PCS offering combined with a cable subscription may be just the right mix to attract them.

The Background of the Broadband Auctions

In the 1993 *Omnibus Budget Reconciliation Act*, Congress directed the Federal Communications Commission to allocate radio frequency spectrum for Personal Communications Services by competitive bidding. The act also included a mandate that the FCC provide opportunities for small businesses, women- and minority-owned firms, and rural telephone companies, lest the auction be dominated by the industry giants. These are collectively referred to as Designated Entities, or simply DEs.

The FCC then went through several rounds of proposals on how to group the spectrum into blocks, eventually issuing its *Broadband PCS Reconsideration Order*, which established bandwidth assignments and area designations. Table 3 summarizes the results of this order. It allocated 120 MHz of radio spectrum in the 1.9 gigahertz band (GHz) to be licensed based on competitive bidding. It establishes three 30 MHz licenses and three 10 MHz licenses. Two types of service areas were es-

tablished—51 Major Trading Area (MTAs) and 493 Basic Trading Areas (BTAs), which are geographic territories defined in Rand McNally's *Commercial Atlas & Marketing Guide*. Maps of the MTAs and BTAs are shown in Charts 9 and 10. For the 51 MTAs, Table 4 shows key the demographic statistics that will be considered by the bidders for these licenses. The MTAs and BTAs differ significantly from the cellular territories, known as Metropolitan Statistical Areas (MSAs) and Rural Service Areas (RSAs), which were rejected for PCS as inaccurate reflections of commerce patterns in the United States. Proposals to establish nationwide licenses were also rejected.

The licenses in frequency blocks A and B are to be awarded on an MTA basis, with blocks C, D, E, and F to be awarded on a BTA basis. This creates a total of 2,074 licenses in broadband PCS. Three of the MTA licenses have been awarded to firms that had conducted pioneering work in PCS technology. The Pioneers' Preference winners are Omnipoint in New York, Cox Cable in Los Angeles, and American Personal Communications in the Washington-Baltimore area. While initially, these three licenses were to be free, a hue and cry rose from the Pioneers' Preference losers, and eventually from politicians, that this was too big a giveaway of public property. Eventually, it was decided that the winners would have to pay 85% of the average winning bids (on a per-POP basis) in the top-20 markets, excluding the three markets where only one license is to be auctioned.

In July 1994, the FCC released its *Fifth Report and Order*, which established the rules for the broadband PCS auction. This document runs to over 150 pages of detailed definitions and procedures, which we will try to summarize in a few bullet points.

- *It caps the amount of spectrum ownership by any one entity in any given area to 40 MHz, including cellular spectrum.* The implication is that at least three, and possibly six, new wireless players will arise in each area of the country. It also means that incumbent cellular operators can bid only for 10 MHz blocks in their existing regions. After January 1, 2000, cellular operators can acquire another 5 MHz to come up to the 40 MHz limit. This suggests that the FCC may allow licenses to be

Table 3
PCS Spectrum Blocks

Frequency Block	Amount of Spectrum	Geographic Scope	Frequency Range
A	30 MHz	MTA	1850-1865 / 1930-1945 MHz
B	30 MHz	MTA	1870-1885 / 1950-1965 MHz
C	30 MHz	BTA	1895-1910 / 1975-1990 MHz
D	10 MHz	BTA	1865-1870 / 1945-1950 MHz
E	10 MHz	BTA	1885-1890 / 1965-1970 MHz
F	10 MHz	BTA	1890-1895 / 1970-1975 MHz
Unlicensed	20 MHz	Nationwide	1910-1930 MHz

Each frequency range is split in half and separated by 80 MHz to facilitate inbound and outbound channels. A is adjacent to D, B is Adjacent to E and C is adjacent to F to facilitate aggregation of 40 MHz of contiguous spectrum, the limit allowed.

PCS: A Critical Piece of the Communications Puzzle

Chart 9

PCS Major Trading Areas - MTAs

As defined by Rand McNally's Commercial Atlas & Marketing Guide

